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FOUNDRY TRADE JOURNAL
Established 1902
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Sharing the "Know How"

We confess to a personal dislike of the expression "know how," but as apparently there is no single word which implies a combination of technical knowledge and experience, we have reluctantly included it in our vocabulary. We have done this because we were impressed by an article in "Metal and Alloys" by Dr. Zay Jeffries, the well-known American metallurgist. In it he has given it as his considered opinion that despite the sevenfold expansion in the production of aluminium and the hundredfold increase in the output of magnesium, "*the most important metallurgical engineering development of the war is the opening up by industry of its great bank of metallurgical 'know how' to competitors and non-competitors alike, with little regard for post-war consequences.*" We would add that, moreover, this has been done with full knowledge that the risk has often to be taken that the "know how" will even reach enemy territory. The more one ponders upon the implications of Jeffries' assertion, the more one is impressed with its importance. The Dominions, for instance, have had the advantage of the enthusiastic co-operation of British and American engineers in their wartime munitions planning and production, and "know how" once given is a permanent asset. The international exchange of information has been on the largest scale, but it has been paralleled by national activities. Generally speaking, and because of the natural consequence of the impact of war, British national efforts have preceded those of America. Thus, war savings; rationing; black-out; paper, scrap, tin and rubber salvage; fire prevention, have all become major topics of interest in the American Press long after they have become part and parcel of British routine. As a prophesy we would hazard that the next campaign to be envisaged in the States is fuel economy, and British experience has proved it to be the most fertile field for the sharing of the "know how." It has been one of our most pleasurable wartime duties to participate actively in this campaign, and we believe that lasting and beneficial results will accrue to British industry. In our own industry, one reaction was the creation of a peg upon which to hang a hat and an overcoat for the manufacturers of brass and bronze castings. It has provided all industries with a free consulting service of an invaluable character, due to the fact that not only is a detailed report given by a highly qualified inspector, but that report is inspected by a committee to ascertain and endorse or amend any advice given. Moreover, where serious economy would be forthcoming through the installation of new plant, the influence of the Ministry is brought to bear upon the appropriate authority for its provision. Yet gossip has it, that there exists a handful of concerns, the managements of which are so smug and self-satisfied that they fear the sharing of their own particular "know how" with their colleagues, would be detrimental to their own petty commercial interests. Thus they place every obstacle in the way of a Ministry which has but one objective, the aiding of the war effort, by helping each individual firm to operate more economically. The truth about these concerns which will never attain any considerable dimensions, is that their "know how" is of such an empirical character that a major change in their key staff or an important raw material would throw their technique all hay-wire. It must not be thought that we are attacking the small jobbing foundry; on the contrary, our experience of their wartime activities is most encouraging. They are in many cases handling more money than ever before, and are quietly making very intelligently throughout improvements to their establishments, and above all they are learning to appreciate to apply the "know how" so lavishly placed at their disposal by their industrial colleagues.

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MACHINE FOR CASTING INGOTS

THE BAGSHAWE MODEL

A letter received from Bagshawe & Company, Limited, Dunstable, points out in reference to the article which we printed on page 248 of our issue of November 25, that they supplied a machine which is the same in all essential details to the one described in July, 1931, to Ford's factory at Cork. This machine was, the following year, transferred to

FIG. 1.—BAGSHAWE MACHINE FOR CASTING INGOTS.

Dagenham, where it was slightly altered and extended. The only main difference is that this machine was for cast iron pigs, where the melting point is nearly double that of aluminium.

It was found to be unnecessary to instal any elaborate apparatus for cooling the moulds, and the method of dealing with the expansion was extremely simple. With regard to the variation in speeds, the usual method of dealing with this matter is to have a variable speed gear. The machine is shown operating in Fig. 1.

NOTES FROM THE BRANCHES

Wales and Monmouth.—The attendance at lectures when coupled with a works' visit of general interest has been more satisfactory than when a lecture only is announced. This was the case on December 4 when a visit to the Castle Rolling Mills of Guest, Keen & Nettlefolds, Limited, Cardiff, was followed by a lecture by Mr. H. G. Warrington, of Slough. At the works members were shown the rod and strip mills in operation, and the wire drawing, annealing and nail factory were also visited. Following this most interesting tour, tea was provided at the canteen, where approximately sixty members were present.

Adjourning to the lecture room, the members were addressed by Mr. Warrington upon his already published Paper, "A Method of Correlating Foundry Practice and Quality of Light Alloy Castings," illustrated with a number of lantern slides. After a prolonged discussion, a very hearty vote of thanks was moved by Mr. McClelland, and seconded by Prof. Jones, to Guest, Keen & Nettlefolds for a most interesting visit and generous hospitality. Mr. Phipps replied on behalf of the company.

Mr. R. G. Williams moved, and Mr. A. L. Pendrey seconded, a vote of thanks to Mr. Warrington for so ably expounding his Paper, and replying to the questions, the latter stressing the generosity of Mr. Warrington's firm for permitting him to give of his experience for the benefit of the industry. Mr. Warrington in reply expressed his pleasure in this his first visit to the South Wales Branch.

South Africa.—A visit to the steel foundry of the Union Steel Corporation at Vereeninging was well supported, no fewer than 55 members participating. Mr. J. Tonge and Mr. Bragg took charge of the party after a speech of welcome from Mr. Anderson. The foundry contains furnaces ranging from 4-ton electrics to 50-ton open hearths, which are also used for ingot making. Much interest was aroused in the quantity production of 250-lb. bombs using jolt rollover machines. After tea, Mr. Nimmo Dewar offered a two-guinea prize for competition amongst the younger members for a description of what they had seen that day. Mr. J. M. Stones, the Branch-President, announced that Colonel Guy had placed a sum of ten pounds in the hands of the Council for any purpose they deemed fit.

Stainless Steel Film

A new motion picture has been released by the Bureau of Mines, titled "Stainless Steel," which traces the production process of stainless steel by the Allegheny Ludlum Steel Corporation. The theme of the picture is established by depicting a simple experiment contrasting the corrosion-resistance of stainless steel as compared to ordinary steel. The qualities apparent in stainless steel are then explained by a visual tour through the Allegheny Ludlum plant in Brackenridge, Penna. The film has been widely shown in the United States at industrial and other training classes.

DEVELOPMENTS IN THERMAL TECHNIQUE AS APPLIED TO VITREOUS ENAMELLING PROCESSES

Paper read at the Annual General Meeting of the Institute of Vitreous Enamellers

By J. FALLON (Incandescent Heat Company, Limited, Smethwick)

In the range of processes involved in vitreous-enamelling practice, the important bearing of the five main thermal processes, i.e., fusing, drying, degreasing, annealing and frit melting, on both the cost and the quality of the finished product, is receiving greater recognition. Investigation of these processes affords perhaps the most fertile field of inquiry within the industry. As a considerable percentage of vitreous enamellers do not manufacture frit, the thermal processes involved may be classified in order of importance as follows:—(*a*) Fusing; (*b*) drying; (*c*) degreasing and annealing; (*d*) frit melting, and (*e*) ancillary processes such as vat heating, etc.

As essential and series links in the chain of processing, the correctness and general efficiency of thermal treatment, which in practice varies between very wide limits, has an important influence and may make or mar balance-sheets results, including even the important item of goodwill. Is it possible, therefore, in these days of stress, to comment usefully upon ascertained practice, to correlate advances and progress made in thermal processing within and outside the industry, to envisage a field of inquiry, and to deduce therefrom information or pointers which may guide and influence us in the consideration of these important phases of our work?

To avoid dilution, and to contain and focus our thoughts more appropriately on the subject matter of this short review, it seems necessary to avoid reference to the pre-processing of goods as delivered to the enamelling shop, involving questions relating to quality and characteristics of metal and frit, surface preparation, i.e., shot blasting, chemical or solution cleaning methods, filling, etc., and to confine ourselves strictly to the problems of thermal processing.

Fuel

Touching generally upon fuel problems, it may be said that from the point of view of national economy, war has given a healthy impetus to the necessity of utilising more fully and scientifically heat energy derived from fuels indigenous to this country, either in the raw or prepared forms, as follows: (1) Bituminous coal; (2) anthracite; (3) coke; (4) town gas; (5) electricity, and (6) home-produced oils.

The high convenience factor of both town gas and electricity is well known, but in cases in which central service supplies are either not available or prohibitive in cost, much has been done to increase the flexibility of application, control, economy and efficiency of solid fuels under items 1 to 3 by the use of clean producer gas plants, automatic stokers, etc.

Functions of a Furnace or Oven

The furnace or thermal unit, together with its auxiliary apparatus, has the following main functions:—

(1) To receive fuels or electricity containing heat energy in latent form, to convert this latent heat energy into sensible form, and to transmit heat so generated uniformly, under conditions of precision control and at the maximum rate permissible, to goods under treatment. The primary aim is to transmit the largest possible percentage or proportion of heat, as received, to the useful load, which percentage represents the practical working efficiency of the unit.

(2) As no perfect heat insulator or heat conductor exists, it follows that the furnace unit must function in two ways:—(*a*) In facilitating heat flow to the useful load by radiation or convection or both, and in retarding heat flow (which is a loss) through outer or containing walls of the furnace structure to the atmosphere. (*b*) In utilising unavoidable heat emission from the furnace, in the form of waste gases and the cooling load.

(3) The delivery of the useful load to, and removal of it from the heating zone of the furnace, by means of charging and discharging apparatus or conveyors.

Materials of Construction.—In the wide range of materials available for furnace construction, the thermal conductivity of the highest quality insulator in relation to that of the highest quality conductor is in the ratio of over 1 to 100. The appropriate disposition of these materials in a well-designed furnace structure, in which due attention is given to its stability and maintenance, has an important bearing on ultimate efficiency and cost of operation.

FUSING FURNACES

Static In-and-Out *versus* Continuous Types

Just as the simple smith's hearth as a form of heating unit has maintained its rightful place throughout the industrial era, so, in the author's opinion, the static in-and-out furnace will always maintain a useful, if decreasing, sphere of application throughout this industry.

Market requirements such as the vitreous enamelling of large chemical vessels, load demand and variety of work handled by the small jobbing plant, militate against the universal application of continuous methods. It follows, however, from developments in other industries, in which, on application of continu-

Vitreous Enamelling Furnaces

ous methods, the costs of thermal processing have been reduced to a fraction of those involved in the use of static furnaces, that the application of the continuous furnace within this industry has lagged, and that static furnace practice has been maintained to a degree far beyond economic justification.

It is true that many mechanical aids have been applied to static furnaces in the form of special purpose machines for charging and discharging, mechanically-operated doors, automatic temperature and time controls, etc., and that the standard of construction and efficiency of the static furnace has been improved. It is clear, nevertheless, that there are definite limitations inherent in the static system, and equally so, that given suitable loading or demand, the continuous unit offers great scope for increase in economy of fuel, labour and space, coupled with improvement in quality and uniformity of the resultant product.

The Conventional Static Furnace

It was realised by early workers that combustion gases interacted detrimentally with most enamels during the fusion process, and that such gases should therefore be excluded from the working chamber. The size of the working chamber, *i.e.*, its width, length and height, was determined by the size of the individual load. Having determined that an enclosed muffle chamber is necessary, and its size, also that good-quality refractory material should be used, the secondary problem was to decide upon a practical method of heating so that heat would flow through the hearth, walls and crown of the chamber (the inner surfaces of which would function as radiators and by this means transmit heat to the load). The rate of heat absorption by the load invariably exceeded the rate of heat delivery through the muffle and the muffle therefore became the limiting factor, or bottleneck, which retarded throughput.

As opposed to electrical practice, in which porcelain is used for insulation and copper for conduction, the same materials were used in the outer walls of the furnace for insulation or prevention of heat flow or loss from the combustion chambers and channels surrounding the muffle as were used in the muffle walls for transmitting or conducting useful heat in the reverse direction through the muffle to the load, and, as a result, thermal efficiency and throughput were of a relatively low order.

Excessively high temperatures were maintained in the combustion chambers and flues surrounding the muffle, causing fusion of brickwork and high maintenance charges. For the maintenance of internal working temperatures of, say, 900 deg. C., combustion chamber temperatures of 1,400 and 1,500 deg. C. were, and are still, frequently met with. Forge furnace conditions were maintained under and around these muffle structures, as the necessary temperature and reasonable output could only be obtained by maintaining a considerable temperature difference between the outer and inner faces of the muffle walls.

Subsequently, improved qualities and types of refractory materials which became available, resulted in the use of silica, silicon carbide, electrically fused alumina and heat-resisting metals for the construction of the muffle or working chamber, and assisted its function of a heat valve in reducing resistance to heat flow from the source to the heating chamber. In this evolutionary process, bricks costing 2d. or 3d. each were replaced by bricks costing 4s. 6d. or 5s. each, but generally the same principle of heat generation and transmission was maintained.

The Ideal Furnace

Had a physicist familiar with the processes and laws of heat transmission been faced with this problem in early days, it is possible that development towards the ideal furnace would have been greatly accelerated.

To give an example:—If it is desired to heat an ordinary room by means of radiators to a temperature of, say 70 deg. F. and sufficient radiating surface is applied, the room may be overheated by this method with surfaces maintained at a temperature of 100 deg. F. If, however, radiating surfaces are restricted, as in the extreme case of an electric heater, resistor temperatures of 1,000 deg. C. or over (involving the use of high quality nichrome wire) are necessary to maintain the same room at a temperature of 70 deg. F. So it is with the fusing furnace. A furnace having a working chamber of, say, 15 ft. by 5 ft. by 3 ft., has an internal radiating surface of approximately 250 sq. ft., of which the active surface rarely exceeds 200 sq. ft. If, however, we depart from the conventional chamber determined by size of load, and consider the characteristics of the material through which we wish to transmit heat, then it is found that with an ordinary quality refractory material of relatively low basic cost, the heat requirements of the chamber can be quite easily transmitted through this material if the heat radiating surface is sufficient.

In practice, a muffle chamber of the size specified, provided with a heating surface of 750 sq. ft., *i.e.*, three times that of the conventional chamber, enables furnaces so constructed to be operated with combustion chamber temperatures little more than 100 deg. C. in excess of the actual internal working temperature required (*i.e.*, 1,000 deg. C.), *viz.*, within safe working limits of the materials used, with the result that many years of service can be obtained at the highest working temperatures without major repair. Breakdown of materials by vitrification or fusing is entirely avoided. Furthermore, by applying heat at many points through refractory tubular radiators which provide adequate heating surface, the physical disadvantages arising from the firing of the whole of the fuel from one point with the resulting destructive combustion chamber temperatures, is eliminated.

It follows, also, that when high temperatures are maintained in the combustion chambers and channels surrounding the working muffle, any temperature control point within the working muffle has interposed between it and the source of heat generation, large masses of materials maintained at excessive temperatures. Consequently, temperature control for loads

demanding a short time cycle of just a few minutes, which actuate a heat source remote from the working chamber proper, must of necessity be out of phase with the temperature cycle or load requirements. The harmonic flow of heat through high temperature combustion chambers and then through the walls of the muffle, involving temperature shift of many tons of material, often demands a time factor exceeding by many times that required for the complete heating of the load from the time of charging to discharging. It is, in fact, a method of crude compromise.

Rapid Temperature Shift and Radiation Losses

The flywheel effect, thermal capacity, inertia or lag, due to the interposition of large masses of high temperature materials between the point of control and the point of heat supply, prevents close time and temperature phase relationship with the load, which latter condition is a fundamental requirement of precision controlled heating. By constructing furnace units with the correct materials, properly disposed according to their several functions, it is possible by automatic control to obtain temperature shift within the working chamber within ten seconds, as compared with ten minutes or more necessary in under-fired combustion chamber types.

It is, of course, necessary to open and close the door of a static furnace more or less frequently according to the class of work. Unfortunately, door openings are more frequent when handling light gauge sheet iron at high temperature than in handling cast iron of greater thickness and at lower temperatures, i.e., 900 deg. C. and 750 deg. C. respectively. Assuming ten door openings per hour, each of 1 min. duration, on a fusing furnace 5 ft. wide with 2-ft. 6-in. door lift, operating at 900 deg. C., then the heat loss by radiation due to each opening exceeds 7,000 B.Th.U. per min., and at 750 deg. C., 4,000 B.Th.U. per min. In the first case, the theoretical heat loss is 70,000 B.Th.U. per hr., which in terms of town gas having a calorific value of 475 B.Th.U. per cub. ft., operating at normal efficiency, is equal to the loss of 300 cub. ft. per hr. In practice the loss is greater and more nearly 500 cub. ft. per hr., due to additional heat loss from door lining surfaces, convection currents, etc. This form of heat loss is unavoidable in the static system.

Many of the early difficulties cited in relation to the static furnace can be, and have been, overcome. These problems are, however, greatly reduced in the continuous furnace, which is maintained throughout its length in thermal equilibrium during its period of useful work. For instance, its preheating section always receives cold work; its soaking section maintains work within the required time and temperature limits; its cooling section dissipates heat at a predetermined rate; the demand on each section is uniform at all times and hunting and oscillation are avoided.

If the continuous furnace affords such advantages, why has its adoption been so retarded?—It is the opinion of the author that possibly in this country we have been too prone to follow the American lead and practice which, whilst appropriate in that country with its enormous home market demand, is not so well suited to the market conditions obtaining in Great Britain. It is doubtful whether a large unit—large in capacity and equally so in first cost—*i.e.*, the continuous horseshoe type, is likely to be a practical proposition in this country except in relatively few instances. It is unnecessary to dilate on figures of first cost, revision of layout of existing shops to accommodate such units, etc. It is sufficient to say that the problem of the introduction of the continuous method as applied to fusing merits our most intensive thought and consideration.

Continuous Furnaces in Enamelling Shops

What are the prerequisites in the successful application of continuous methods to the average vitreous enamelling shop?—In the author's opinion, they are as follow:—

(1) In the continuous furnace, labour is required to load and unload; therefore, the capacity of the furnace should be such as will utilise fully, within reasonable limits of the capacity, say two loaders and two unloaders. This single point goes far to determine capacity or size.

(2) The ware loaded cold at the charging point should be sufficiently cool at the discharge point to permit of hand handling.

(3) Between points of loading and discharge, the furnace unit should be completely automatic, both as a conveyor equipped with variable speed control, which determines the time cycle, and a furnace with automatic temperature control, which governs the temperature cycle, so that in combination the conveyor and furnace time and temperature cycles are correctly related. Resolved down, this means that a continuous furnace unit consisting of a suitable and reliable conveyor, plus a furnace section incorporating preheating, heating and cooling, constitutes a precision thermal machine.

What are the developments in other industries, and how nearly do types so developed meet the requirements of our industry?—The great problem in the continuous furnace, the heating of which is relatively simple, is the provision of a transport system suitable for handling goods at elevated temperatures, with minimum depreciation. There is little use in constructing continuous units which save labour at a point on the operating floor, to succeed only in transferring this labour to the fitting or maintenance shop. Various types of continuous units in respect of transport system are available, *i.e.*, the split crown units carrying work in suspension on drop hangers, usually involving a working chamber of considerable height, which in turn necessitates special sealing methods or camel backing to prevent excessive outflow of heat at each end, due to thermal convection currents, *i.e.*, cold air going in at the bottom and hot air coming out at the top. It may be said that the split crown drop hanger type is best suited to extremely high capacity units of considerable length, arranged either in a straight line or horseshoe fashion, and that the drop hanger

Vitreous Enamelling Furnaces

split crown type of unit does not lend itself readily to units of moderate or small capacity, and is not suited to our average demand and conditions.

Best Form of Unit

What form of continuous unit is then most likely to fit our conditions and methods of working?—Live roll conveyor units of continuous type, with chamber sizes comparable with those used and required in our industry, are working successfully in continuous operation, i.e., up to 168 hrs. per week, month in, month out, at temperatures exceeding 900 deg. C., in many cases handling materials destined for vitreous enamelling processes. In the author's opinion, therefore, a simple live roll conveyor unit, transporting perrit bars of standard size such as used in static units, or of special size to afford suitable grouping of the load, is, according to present developments, the nearest possible ideal answer to this problem. In such a furnace, the driving mechanism is so arranged that the perrit bars at the loading point remain static during the period of loading, thus facilitating the careful emplacement of the load on the perrit points.

The load progresses at a speed which is indicated and recorded and appropriate to the gauge or thickness of the material under treatment, thus giving the necessary and controlled time element to effect perfect and uniform fusion, and avoiding over- or under-heating. The work progresses through a cooling chamber, and then to the discharge point, at which, after removal of the load, the perrit bars are automatically returned to the charging position. This type of unit is straight line, simple, flexible and highly efficient. It may be fired by town gas, clean producer gas through metallic radiant tubes disposed over and under the load, or alternatively heated by electric resistors, with equal effect, commercial efficiency being dependent on the relative costs of heat energy as purchased.

Problems of conveyance, control, insulation and firing, with related maintenance charges, have all been fully determined. Striking developments have been made in recent years in conveyor design, the elements of which may now be considered troublefree. In regard to the design of perrit bars, these may be reduced in weight to approximately one-third of those at present used in static furnaces due to the short span and varying points of support in transmission through, say, a furnace of the roller conveyor type which tends to prevent rather than promote warpage. A continuous fusing furnace utilising four operators, i.e., two loading and two unloading, will displace at least four units of the conventional static type.

An interesting fact, but of little relevance to the point under discussion, is that in viewing a load progressing through a straight-line furnace with the darkened exit aperture in the background, a light, continuous and somewhat ethereal cloud of gas can be observed emanating from the load during its primary phase of heating.

Gas Pickling

Further possibilities are opened up in the application of continuous units which, if sealed and provided with a conditioned atmosphere, are suitable for processing difficult beaded ware for the purpose of gas pickling, which is effected at temperatures ranging from 800 deg. C. to 900 deg. C. Steel pressings so processed, with slightly blue or rusty surfaces or containing a very light oil film, emerge from the system metallically clean and bright. Tests and experiments in subsequent vitreous enamelling of ware so treated demonstrated that the steel is practically free from occluded hydrogen often present after acid pickling, and that the trapping of carbon and other deleterious materials in the beaded sections, with consequent gassing troubles during the process of fusion, is eliminated. Developments in gas pickling point to an interesting and useful, if somewhat limited, sphere of application in our processing.

DRYING AND OTHER APPLICATIONS

Possibilities of Infra-Red Heating

Infra-red radiation, as opposed to convection heating, has received much publicity, and has engaged the attention of many concerned with heating and drying problems. Its application so far has been mainly directed to the drying of paints, varnishes, and low temperature enamels. In principle, the infra-red oven is provided with radiators or radiating surfaces from which heat is radiated mainly within the infra-red band directly on to the surfaces of the goods under treatment. Remarkable results have been obtained. Certain drying and stoving operations have been accomplished in, say, three minutes, as against sixty minutes required for accomplishing the same result in the ordinary convection oven.

Radiation is transmitted through an atmosphere which may be relatively cool, but as heat so radiated travels in straight lines from source to receiver, it follows that the surfaces to be heated by infra-red methods should, as heat receptors, be disposed on conveyors, whether horizontal or vertical, in such a manner as will face the heat source, in the same way as they would receive light if the object was to illuminate the surface. That it is not always convenient in our industry to arrange and dispose work in this manner is evident.

With certain classes of drying, particularly the flat plate single-coat type using horizontal conveyors, or double coat in vertical suspension, it is obvious that infra-red methods of heating are applicable. A physical point which must be appreciated to judge the possibilities of infra-red is that the heat source is maintained at a temperature very much greater than the ultimate temperature to which the goods are heated, so that the temperature finally attained by the goods is regulated by the time of exposure to radiation. Prolonged exposure causes overheating; under-exposure under-heating. A variable speed conveyor is therefore a prime essential to the success of the process when operating continuously.

The radiators may be of the electric bulb and reflector type or gas heated radiating surfaces, with both of which methods satisfactory results can be obtained, the operating results and costs being dependent, as in other processes, on the cost of heat energy as purchased, plus maintenance.

From the foregoing it will be clear that where multiple stacked goods are to be subjected to the drying process, infra-red is not a feasible or economic proposition and is not likely to displace either the static, continuous straight line or camel-back drying oven. For relatively flat plate sprayed or dipped work with horizontal or vertical loading, the main advantage of the infra-red type oven is that of shortening the oven section and thus economising space requirements. There is no evidence available so far that any economy, either in heating or overall operating costs, or any measurable improvement in quality of drying may be expected from its application to this industry. Considerable advance is being made, however, in the application of the infra-red method of heating in the directions indicated and experiments are now being carried out to determine what, if any, advantages may accrue from its application to the drying of certain classes of products met with in our industry.

Convection Ovens

The modern convection oven, of either static or continuous type, with mechanically recirculated atmosphere, scientifically designed, is a high-efficiency unit, any further improvements in which will be by small increments or refinements. The increased application of the continuous method has been well justified in practice both from the point of view of fuel and of labour saving.

Convection methods of heating permit greater flexibility in the form of loading and latitude in heating times, which, coupled with precision temperature control, avoid overheating of sections of loads which may contain goods of varying thickness or gauge. The continuous straight line and camel-back conveyor type recirculated atmosphere drying oven has, through its efficiency and convenience, reached a well-established place in our industry which is likely to be maintained.

Annealing and Degreasing

Wherever layout conditions and other factors will permit, the annealing of castings should be carried out by continuous methods which give the advantage of slow preheat and slow cooling coupled with fuel economy of an order which cannot be obtained when both furnace and load are heated up, soaked and cooled together as in the static furnace.

Degreasing may be carried out in static or continuous ovens, and methods applied usually follow the general practice of the shop in relation to fusing operations. The author suggests as a useful field of inquiry further investigation as to the possibilities of degreasing in furnaces of controlled atmosphere of the relatively neutral type, as affording desirable protection to the goods so treated by elimination of oxidation.

Frit Melting

From the point of view of thermal efficiency, temperature control, and contamination of the product, the average frit furnace, whether of the static, rocking or rotary type, is a notoriously inefficient device. Whilst operating at relatively high temperatures, little progress has been made in the recovery or utilisation of waste heat, although there are, of course, a few important instances in which, by means of recuperation or regeneration, considerable economy has been achieved. The displacement by gas firing of other fuels with their contaminant properties, has been effected in the United States on a large scale, and the changeover justified by improvement of both quality and purity of the product.

The subject is one of vital importance to the vitreous enamelling industry, and is such as would require the full scope of this Paper to deal adequately with the main principles involved and suggested revisions of existing practice. The work done in parallel fields of thermal heat engineering indicates, however, that optimum thermal efficiencies can be obtained in units of relatively small size as compared with the larger American units and, therefore, are readily applicable to the requirements of the British market. Long overdue and drastic improvements may be expected in the methods and processes of frit melting on the resumption of normal demand within our industry.

In conclusion, if the foregoing remarks indicate in some small measure the development and trend of thermal technique as applied to the problems and processes of vitreous enamelling, or, alternatively, provoke further thought on these important subjects, they will have served their intended purpose.

S. AND P. IN PIG-IRON

The Blast Furnace Materials Analysis Sub-Committee of the Blast Furnace Committee of the Iron and Steel Institute has prepared a Report on "The Determination of Sulphur and Phosphorus in Pig-iron." It is stated that the most promising method for reducing divergencies to a minimum when analysing for sulphur is by a standardised procedure for the combustion technique. A full description of this method is set out and a table of results given by nine different laboratories stresses its reliability. As to phosphorus, the Report shows that the method published by the B.C.I.R.A. needed modification. This is set out in detail in Appendix III. It is a slightly longer method than the original one.

Furnace Insulation.—Painting hot surfaces with ordinary paints is quite useless, but aluminium or even bronze paints, if obtainable, do reduce the loss of heat quite considerably. They are not an effective substitute for lagging, but they are considerably better than nothing.

SAVE ALL PAPER

RADIOGRAPHY AS AN AID TO FOUNDRY PRACTICE

MR. GLADWELL'S PAPER BEFORE THE EAST MIDLANDS BRANCH

This Paper, which has already been printed in our columns, was presented to a meeting of the East Midlands Branch on October 23. Mr. W. H. Smith presided, and in the absence of the author, Mr. W. C. Gladwell, the Paper was presented by Mr. R. L. Durant.

The discussion was opened by MR. F. G. BUTTERS, who said the Paper should not be looked upon with suspicion and distrust, but should be regarded more in the way of an advancement of modern science which had been developed to help the foundryman, and he should take advantage of all possible knowledge which will help him to produce better castings. The interpretation of the slides was very difficult, because one may get more than one cavity, in which case it would be necessary to take several shots. Another advantage was when dealing with high liquid shrinkage non-ferrous metals. In his own particular line of Diesel cylinder heads it was a very valuable means of testing a casting without destroying it. The chief value was in the technique of running and feeding.

MR. DURANT, referring to the interpretations of slides, pointed out that they were the outcome of several photographic processes, thus much contrast and definition were lost. One could not see some of the flaws on the final slide, which were readily visible on the original radiograph. Mr. Butters raised the rather awkward question of one cavity on top of another. This was a very rare happening, but when it did occur a second radiograph might be needed to elucidate it.

MR. H. BUNTING said the Paper had been most interesting to those who know nothing about radiography. He asked how far could the rays penetrate into cast iron. Most of the illustrations related either to the non-ferrous alloys or steel. There was, he thought, considerable difficulty in applying the process to cast iron. Was this due to various constituents making up cast iron?

In reply MR. DURANT said the degree to which one could penetrate any material, including alloys, depended entirely upon its density. His firm radiographed sections of copper as thick as 8 or 10 in. At the moment the technique was not perfect, but at least an attempt was made which gave some sort of a guide as to what was inside. With gamma rays the technique was fairly certain for thicknesses up to 6 in. of copper, and would show a flaw 3 to 4 per cent. of the thickness of the metal. In the case of steel and cast iron, which are slightly lighter than copper, one could penetrate a slightly greater section. Six inches of copper would be equivalent to seven inches of steel or cast iron.

Influence of Casting Surface on Radiographs

MR. A. E. PEACE said he had been interested in the radiography of metals in a rather elementary way for a number of years, and he felt that to stimulate interest foundrymen needed the features of radiography putting in front of them in a simple manner. Obviously one must have an expert to take the radiographs, but the foundryman must translate the information into practice. It was therefore necessary for the foundryman to learn how to interpret the pictures. How did one differentiate between a blowhole and a slag inclusion and perhaps unsoundness? How did one tell the difference between a crack and piping? Presumably they may all give a similar density.

It was interesting to note the very clear definition in many of the radiographs, as he was under the impression that there was a lot of scatter effect. It appeared, however, that the technique had been considerably improved, and he asked what means were adopted to get this splendid definition. Another aspect was that some castings had a very good skin and finish, while others were not so good and were rough, and these surface blemishes must affect the picture. How were such defects prevented from conveying an ill-effect upon the radiograph? A similar possibility occurred in the use of numbers, letters, and trade mark designs. Foundrymen must know where these markings were on the castings, so that they could recognise them when they see them on the radiograph.

MR. DURANT in reply said that the technique of interpretation of radiographs centred round familiarity with the castings radiographed. The radiographer should follow manufacture from the time the pattern was made until ready for dispatch, and should know its shape, and any numbers, letters and trade marks which would appear on the casting. When the radiograph was processed he should try to have the casting by the side of the radiograph so that these markings could be noted. To differentiate between a blowhole and a slag inclusion was a matter of experience in appreciating the contrast of the defects. For instance, a blowhole was assumed to be vacuum and consequently had no density, but in the case of a slag inclusion there was other material inside that defect which would tend to increase the density of the defect and decrease the differences in density between the defect and the metal. Therefore one got a lower contrast. Either by experience or more satisfactorily by such films as Mr. Gladwell had shown with markers on, one could compare two radiographs by the different density.

As regards cracks and piping, both gave a very characteristic appearance in the radiograph. Piping may be considered as elongated blowholes since both contain only vacuum. Cracks would, in general, not be detected unless they are parallel to the plane of the beam of X- and gamma-rays, and even then not unless they are fairly wide and deep. Cracks were the most difficult to find. Scatter was rather a bugbear to the X-radiographer, who did have to use marking. He had two prints of radiographs of the same casting examined by X-rays and gamma-rays, and owing to the high degree of scatter in the X-radiograph, quite a number of defects near the edge of

(*Continued on page* 315.)

BRITISH CAST IRON RESEARCH ASSOCIATION

TWENTY-SECOND ANNUAL REPORT

Summary of Annual Report and Report of Annual General Meeting in London on December 9, 1943

ANNUAL REPORT

In the last Report the Council was able to announce the acquisition of new premises, which were secured at the end of 1941 and made ready for occupation by August, 1942. Transfer took place in departmental sections, to minimise interruption to work in progress, and was completed by the end of the calendar year. The latter half of the year under review, to June, 1943, has thus been spent entirely in the new buildings. In May, 1943, the Council arranged a formal opening ceremony.

The Annual General Meeting was held in Birmingham on December 16, 1942. The President, Mr. P. Pritchard, and the Vice-Presidents were re-elected. The Council re-elected Dr. Harold Hartley as chairman, and three meetings have been held, in addition to seven meetings of the Executive Committee. The Research Committee re-elected Dr. J. E. Hurst as chairman, and eight meetings have been held, while ten meetings of sub-committees have taken place.

Committees and Sub-Committees

During the year the Council decided to make some modifications to the existing committee structure, with a view to post-war development. A Development Committee has been formed as a major committee of the Council, in parallel with the Research Committee, to review the work of the Development Department and to consider the best methods of stimulating in the industry the fullest use and application of the results of experimental work and other post-war developments in foundry technique. The Publications Committee and Education Committee have been amalgamated as the External Relations Committee, so that the number of major committees remains at three.

The Research Committee is aided in its supervision of the research programme by seven research sub-committees, of which five are based on the main divisions in the industry with respect to product, that is, light castings, engineering castings, white and chilled castings, malleable castings and vitreous enamelling. These sub-committees will review all work carried out or projected by the Association for the branches of the industry they serve. In addition, two sub-committees will devote special attention respectively to experimental development in moulding and core sands and refractories, and in fuels and furnaces.

Research and Development

The work of the Association has again been practically wholly directed to assisting the war effort. Constant contact has been maintained with official departments and many inquiries have been dealt with. Certain changes in the war situation have considerably relieved the position with respect to low-phosphorus raw materials and as a consequence further work on dephosphorisation has been deferred. Work has been carried out under two contracts for the Ministry of Supply and a general contract permits work to be done on a number of minor inquiries which either cannot be made the subject of such contracts or as a necessary preliminary to them.

On high-duty irons, the Third Report of the Committee of the Institution of Mechanical Engineers on work carried out by the Association has been issued on alloy cast irons, together with an addendum to the Second Report, completing the work on the phosphoric irons. During the year work in this field has been wholly devoted to the acicular cast irons, a structural type of alloy material which offers great promise for engineering purposes and in which great interest has been aroused both among founders and engineers. For the same Committee, information on the properties of cast iron in relation to design is being collected and collated and one section relating to properties at elevated temperatures has been prepared. Studies of the formation of graphite and microscopically-visible non-metallic inclusions have been continued and work on the high temperature properties of ingot mould materials for the Iron and Steel Industrial Research Council has been resumed. Work is also proceeding on the comparative effectiveness of various ladle additions.

Work on the chemical determination of inclusions in conjunction with the Oxygen Sub-Committee has been confined to the aluminium reduction method for total oxides, but the vacuum fusion equipment for determining both solid oxides and gases is being constructed. The work of the Joint Committee on Moulding Sands has been resumed, and it is hoped that agreed recommendations with respect to equipment and methods for the testing of all kinds of sands in Great Britain will be forthcoming. A report has been issued on clays from British sources suitable for use with synthetic sands and, unless further deposits come to light, this work is completed. A number of possible substitutes for linseed oil and other organic core binders have been examined. Work on the recovery of core sands dealing with sands carrying ash-containing binders is approaching completion. The work on testing and control of vitreous enamels in conjunction with the Institute of Vitreous Enamellers, and on tin opacifiers with the Tin Research Institute, has been continued and several reports have been issued.

The work of the various laboratories has been, or

B.C.I.R.A. Report and Meeting

is being, facilitated by the acquisition of new equipment, for some of which special accommodation is being provided. The Council, on the recommendation of the Laboratory Equipment Panel of the Research Committee, which has met three times during the year, has set aside £5,000 for the period of the year under review and the current year for this equipment. Reference has been made above to vacuum fusion apparatus for the chemical laboratory, which has also been equipped with a Spekker absorptiometer, and is being equipped with spectrochemical apparatus. Machine tool equipment has been provided for the machine shop and the mechanical testing laboratory has been supplied with a fatigue testing machine and creep testing equipment is being obtained. For physical metallurgy, bath and cooling curve furnaces are being obtained, together with dilatometers and apparatus for electrical and magnetic testing. The experimental foundry has been equipped with shot blast and is being equipped with a malleable annealing oven fitted with a programme controller. The acquisition of X-ray crystallographic apparatus is contemplated.

Development Department and Laboratories.—The number of inquiries received from members and dealt with by the Development Department continues at between four and five per working day. The number of routine tests required in connection with the war effort, both on behalf of members and Government departments, reached new high levels. Since the outbreak of war the work done in the chemical laboratory has more than doubled, in the mechanical testing laboratory more than quadrupled, in the microscopic laboratory more than trebled, and in the sands and refractories laboratory has increased by more than one-half. The Association has assisted a number of members to establish their own laboratories and there are signs that the pressure with respect to tests of this kind is being relieved. The Association has continued to co-operate with the Council of Ironfoundry Associations in the work of the Ironfounding Industry Fuel Committee, of which the Director is chairman, and it accommodates the Fuel Officer, Mr. W. J. Driscoll.

Scottish Laboratory.—The Scottish Laboratory at Falkirk (Mr. T. Tyrie, Superintendent) has taken its full share of these increases. Arrangements have been made during the year for improvements in the laboratory, both in accommodation and equipment, and the Scottish Committee are hoping to invite Scottish members to visit the laboratories when this work is completed.

Library and Information Bureau.—The library and information bureau continues with unabated activity in spite of the handicap arising from lack of certain foreign periodicals and the paper shortage, and figures for loans and accessions compare well with previous years.

The " Bulletin " and " Enamelling Abstracts " have appeared regularly at quarterly intervals. Ten External Reports have been made available to members and twelve Research Reports. It is anticipated that the rate of production of these reports will increase following the removal of preoccupations arising out of the transfer to new premises.

Accommodation and Equipment

As indicated in the last report, during the year under review the Association has obtained possession of its new premises. On May 28, 1943, the Council arranged a formal opening ceremony, preceded by a Council meeting and luncheon at which the President, Mr. Percy Pritchard, presided. The opening ceremony was carried out in brilliant weather by Lord Riverdale, G.B.E., supported by the Rt. Hon. Lord Dudley, M.C., Past-President and Regional Commissioner for the Midland Area; Sir Edward Appleton, K.B.E., F.R.S., secretary to the Department of Scientific and Industrial Research; the President; and about 200 members and guests. The function was highly successful and was widely reported in the daily and technical Press. A booklet especially prepared for the occasion, giving an account of the accommodation and equipment, was presented to those present, and this, together with an account of the speeches and proceedings during the day, was circulated subsequently to all members. The Hall continues to excite the admiration and appreciation of visitors, numbering between one and two per working day.

Finance

The statement of accounts shows a decided increase in income over the previous year, and the highest total in the history of the Association. The increase is due in the main to the results of the appeal, referred to below, and to increased membership. The whole of the expenditure involved in adaptation of the new premises and the transfer, together with new equipment, has been met from revenue and the whole of the assets of the Association are written down to nil in the balance sheet. During the year representatives of the Council met the Industrial Grants Committee of the D.S.I.R., following which the sum on which supplementary grant is given was raised from £3,500 to £5,000. The Council is deeply grateful to the Advisory Council of the D.S.I.R. for this concession. The current year is the last of the present quinquennium.

The number of ordinary and trade members now stands at 449, an increase of 63 over the previous year (to date, November, 1943, 22 further members have been elected). The number of Associate members is 42.

In July, 1942, the Council appealed to members to increase their subscriptions for a period up to three years, and this appeal yielded promises totalling over £5,000. A number of the contributors, while committing themselves only for one year, undertook to reconsider at the end of that time, and in July, 1943, these members were invited to continue, and members who had not then contributed were invited to

do so, the Council in the meantime having been able to circulate an account of its stewardship. This second appeal also yielded promises in excess of £5,000, many of them spread over a three-year period. The Council take this opportunity of expressing their warm appreciation to all members who have assisted in this way. In addition, the Council gratefully acknowledge a donation of £250 from the Foundry Pig Iron Producers' Association. A small group of the Executive Committee, consisting of Dr. Harold Hartley and the Director, with Mr. Arnold E. Pearce as chairman, has under active consideration the future income of the Association and the manner in which it may be raised.

In recent months an unmistakable volume of public opinion has expressed itself with respect to the imperative necessity for better provision for scientific and industrial research and development in this country after the war. A brief account of these developments was given in the "Bulletin" for July, 1943. Since that date a further report has been issued by the Parliamentary and Scientific Committee on Scientific Research and the Universities in Post-War Britain, and the Federation of British Industries has issued through its Industrial Research Committee a report on Industry and Research. All this points to the fact that the Government and public opinion alike endorse the importance of increased research in industry, and this has fortified the Council in its determination to place the Association on such a basis as will enable it to provide the technical and scientific assistance needed by the industry in meeting its post-war problems.

The Report is signed by Dr. H. Hartley, Chairman of Council, and Mr. J. G. Pearce, Director and Secretary.

ANNUAL GENERAL MEETING

The annual general meeting of the Association was held at the Connaught Rooms, Great Queen Street, London, W.C.2, on December 9, 1943, being preceded by an informal luncheon. The chair was taken by MR. P. H. WILSON (Stanton Ironworks Company, Limited, Vice-President), in the absence through indisposition of the President, Mr. P. Pritchard (Midland Motor Cylinder Company, Limited).

The DIRECTOR AND SECRETARY (Mr. J. G. Pearce) read the notice convening the meeting. In addition to a letter of apology and regret from the President at his unavoidable absence through an attack of influenza, it was announced that from the same cause Dr. Harold Hartley, Chairman of Council, was also unable to be present. On the motion of Mr. T. M. Herbert, seconded by Mr. A. E. Pearce, the minutes of the previous annual general meeting, held in Birmingham on December 16, 1942, were taken as read and adopted, and were confirmed and signed.

Report and Accounts

The CHAIRMAN, commenting on the unfortunate absence of the President, said that Mr. Pritchard had taken a very great interest in the affairs of the Association for a long time, and it must be a very great disappointment that he was unable to be present that day. On behalf of the meeting, he expressed the wish that Mr. Pritchard would have a speedy recovery. Continuing, the Chairman said he did not know until a short time ago that he was to be asked to take the chair at that meeting. The report for the past year, which had been circulated, was a very comprehensive document, and there was no need for him to enlarge upon it by way of a speech. He therefore formally proposed that the Report of the Council, duly circulated, and the accounts as audited and certified by the accountants of the Association, showing the position of the Association's affairs at June 30, 1943, be approved and adopted.

DR. A. B. EVEREST seconded. There were no comments and the report and accounts were unanimously adopted.

Election of President

The CHAIRMAN said it was a great pleasure to him to propose that Mr. P. Pritchard be re-elected President for the coming year, and that the warmest thanks of the Association be tendered to him for his interest and assistance during the past year.

DR. J. E. HURST, seconding the proposal, said this was the third time Mr. Pritchard had been put forward for the presidency, and he personally was delighted, particularly because, as he had said when Mr. Pritchard was first elected, he regarded him as a true foundryman. Those members of the Executive who had been in close contact with Mr. Pritchard during the past year or two, during the time the activities of the Association had been transferred to Alvechurch, knew how very deeply he had the interests of the Association at heart, and if only because of that he personally was delighted to have the opportunity of seconding this proposition. The motion was carried with hearty acclamation.

The CHAIRMAN, asking the Director and Secretary to convey to Mr. Pritchard how enthusiastic had been his re-election, said it would undoubtedly give him a great deal of pleasure. He again expressed the hope that the President would have a speedy recovery from his indisposition.

Election of Vice-Presidents

The CHAIRMAN, before calling upon Prof. T. Turner to move the re-election of the six Vice-Presidents, expressed the great pleasure of everybody present at seeing Prof. Turner among them and to feel that he had now fully recovered from his recent illness. Prof. Turner, said the Chairman, was a founder of the Association and had contributed much to its success. Prof. Turner still retained a great deal of interest in the Association and particularly in the important subject of cast iron, and the Association could count on his continued support in the future.

PROF. TURNER, who was given a cordial reception, expressed his appreciation of what the Chairman had said and for the manner in which his remarks had been received, adding that it was almost worth while

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being ill to have so much friendship shown him. He said he thought he was as old as any member of the Association because he was in at the beginning. He then moved the re-election of the following Vice-Presidents:—Mr. J. F. Davies (Radiation, Limited, Birmingham), Mr. J. E. V. Jobson (Qualcast, Limited, Derby), Mr. W. B. Lake (Lake & Elliot, Limited, Braintree), Dr. T. Swinden (United Steel Companies, Limited, Sheffield), Mr. P. H. Wilson (Stanton Ironworks Company, Limited, Nottingham), and Mr. Fitzherbert Wright (Butterley Company, Limited, Derby).

MR. S. H. RUSSELL, in seconding, said these six Vice-President were well known in the industry and took the greatest possible interest in the work of the Association. The resolution was carried unanimously.

The CHAIRMAN, as a Vice-President, expressed appreciation of the re-election of his colleagues and himself and also the hope that he would be able to find sufficient time, as fortunately he had during the past year or two, to continue to take an active part in the Association's work.

Election of Members of Council

MR. V. C. FAULKNER moved: (*a*) That the following members of Council, retiring automatically under Article 27, and eligible for re-election, be re-elected: Mr. C. W. Bigg; Mr. E. W. Colbeck; Mr. F. J. Cook, Mr. H. Field, Dr. J. E. Hurst, Mr. G. T. Lunt, Mr. A. J. Richman, Mr. W. Todd, and Prof. T. Turner; (*b*) that the following retiring members of Council be warmly thanked for their services: Mr. T. Firth, Mr. A. Hodgkinson, Mr. F. Horn, Mr. G. Pate, Mr. W. Scott, Mr. A. W. Steven, and Mr. H. B. Weeks, and (*c*) that the following be elected to the Council: Mr. C. C. Booth, Mr. V. Everard, Mr. G. H. Johnson, Mr. W. Thomas, and Mr. J. Shaw. He added that there was a definite policy behind the nomination of these new members. Mr. Booth was the representative of the smaller type of foundry; Mr. Everard was a director of Belliss & Morcom, Limited; Mr. Johnson represented an active group of pig-iron producers; Mr. Thomas would represent the overseas members; and Mr. Shaw replaced Mr. Steven and was now Chairman of Allied Ironfounders, Limited.

DR. J. G. SKERL seconded the proposal, and said Association was very grateful to the members of Council who were retiring and, at the same time, offered a cordial welcome to the new members, who would undoubtdely show the same close interest in the work of the Association. The motion was carried unanimously.

Election of Auditors

MR. A. E. PEARCE proposed the election of Messrs. Overton, Salt & Company, chartered accountants, as auditors of the Association for the ensuing year. MR. W. TODD seconded, and the motion was unanimously carried.

MR. F. WALKER expressed appreciation of the election of his firm as auditors to the Association. On the motion of MR. C. C. BOOTH, seconded by PROF. T. TURNER, thanks were expressed to Messrs. Poppleton & Appleby for the manner in which they had carried out their work as auditors to the Association in the past.

Votes of Thanks

MR. L. TIBBENHAM moved that the best thanks of the meeting be accorded to the Council and members of Committees and Sub-Committees for their services during the past year. He said that as an ordinary member of the Association he had watched the progress made under the direction of Mr. Pearce, and the Council and Committees were to be congratulated upon what had been accomplished, and particularly on the amount of information that was afforded to the ordinary members. It was clear, however, that the Council and the Committees had put a tremendous amount of work into the affairs of the Association. The vote of thanks was seconded and accorded with hearty acclamation.

MR. FIELD moved a vote of thanks to Mr. Wilson for presiding at this meeting. MR. F. J. COOK seconded, and recalled the work Mr. Wilson was doing as Chairman of the Development Council of the Association. That, he said, was an onerous job for a great deal of the success of the future efforts of the Association depended on the energy which was put into that work. The vote of thanks was heartily given.

The CHAIRMAN, acknowledging the vote of thanks, said the work he had been called upon to do that afternoon was not very arduous compared with what he would be called upon to do as Chairman of the Development Committee. However, that Committee was not a one-man show, and there were upon it very useful men who were going to put their backs into the work and tackle that all-important subject during the coming year. He would be only too pleased to try and direct and help to the best of his ability. He was satisfied that the Association would extend the sphere of its activities considerably in the immediate future. The Council and the Executive had for a long time been discussing post-war activities and, indeed, had had a most interesting discussion only that morning to consider the financial position. There was no doubt that if their programme of research and development could be proceeded with on the lines visualised, the Association in a very short time would double its present activities.

Vote of Thanks to Staff

MR. G. R. WEBSTER proposed a vote of thanks to the staff of the Association, and said that the Association had reached it spresent high level due to the tion had reached its present high level due to the untiring work of the Director and the staff. After MR. W. B. PARKER had recorded the vote, which was carried with hearty acclamation, Mr. J. G. Pearce responded, and the meeting closed.

NEWS IN BRIEF

THE UNITED STEEL WORKERS OF AMERICA have formally notified the 485 steel companies with which they have working contracts of their intention to re-open the contracts. Their chief demand is for an increase of 17 cents an hour in their basic wage.

MR. JOHN HENRY JONES, of Irlam, Lancashire, has begun a ten weeks' tour of America. A steel melter, he was formerly employed at the Park Gate Iron & Steel Company, Limited. He is a trade union official, and will take with him to America credentials from the British Iron and Steel Trades Confederation.

THE BUSINESS of George Prentice & Company, metal merchants, of 35, Robertson Street, Glasgow, which was carried on by the late Mr. George C. Prentice, has been transferred by his trustees to Mr. Alexander Grieve, who is to continue the business under the same firm name and as sole partner on his own account.

WORLD IRON AND STEEL PRODUCTION is currently estimated by Prof. A. Durrer, the German statistician, at 130 million tons of pig-iron and 175 million tons of steel ingots, as against 102 million tons of pig-iron and 136 million tons of steel in 1939. Practically the whole of the increased production is credited to the United States.

AT THE INVITATION of Lord Ridley, chairman of Northumberland County Council, representatives of local authorities in Northumberland, Durham and the North Riding, met at Newcastle-upon-Tyne to discuss the post-war position of the district. Ways of preventing a post-war depression and attracting new industries to the area were considered.

THE PARTNERSHIP between Henry Howlett, Charles Edgar Howlett and Stephen Joseph Howlett, carrying on business as oven and furnace builders at Vale Place and Boundary Street, Hanley, Stoke-on-Trent, under the style of HENRY HOWLETT & SONS, has been dissolved. Debts will be received and paid by Charles Edgar Howlett and Stephen Joseph Howlett, who will continue to carry on the business under the same name.

A FALL of $1,030,225 in net profit at $7,049,994 (U.S. currency) is shown in the statement by the International Nickel Company of Canada, Limited, for the three months to September 30 last, as compared with the figures for the preceding quarter. The amount earned on the common stock in the three months was equivalent to 45c., as against 52c. in the preceding period and 43c. in the September quarter of 1942.

THE HYDRO-BLAST system of cleaning castings by means of the impingement of a high-pressure jet of water carrying sand has now established itself in this country. A full scale one-gun demonstration plant is now functioning at the works of the manufacturers, Pneulec, Limited, Mafeking Road, Smethwick, Birmingham. A number of orders has been received, and further plants are due for installation early next year. The Smethwick plant is available for inspection by appointment.

AT A MEETING in Glasgow of representatives of the Clyde Shipbuilders' Association, the North-West Engineering Employers' Federation, the Confederation of Shipbuilding and Engineering Trades, the A.E.U., and the foundry trades, it was agreed that work in the Clyde shipyards will stop for the New Year holiday period on Friday, December 31, at noon, and will resume at the usual starting hour on January 4. The holiday period is of the same duration as that fixed last year.

MR. FRANCIS ALLEN, presiding at the annual meeting last week of South Crofty, Limited, said that owing to the lack of good miners they were unable to increase production of tin. At their wolfram mine at Castle-an-Dinas, the production fell off as the lode became poorer, and they began to sink and equip a new shaft on the opposite side of the hill. Unfortunately, a slide occurred and they encountered an unexpected quantity of water. The work was now practically completed and development on the lode should proceed rapidly.

RADIOGRAPHY AS AN AID TO FOUNDRY PRACTICE

(*Continued from page* 310.)

the casting were obliterated. With regard to surface defects, he found that with most of the castings produced in his foundry, surface defects were rarely deep enough to be recorded on the radiograph. It has been said by competent radiographers that surface defects help to line up what is in the casting.

Graphite Voids

MR. G. L. HARBACH asked how the low density of carbon effected the radiograph? Considering the structure of cast iron containing about 10 per cent. of graphite by volume, he thought it would be possible to register quite a number of voids due to the graphite. Would they be voids to the radiographer?

MR. DURANT replied that with X-ray he imagined that on thinner sections there might be some possibility of showing that effect. He had had very little experience with radiographs on cast iron, so could not be dogmatic. With gamma rays the contrast was much lower, and there had to be quite an appreciable change in density before any difference could be detected on the radiograph. The density of graphite being 2.3, and that of iron 7.8, it will be seen that 10 per cent. of graphite, as in cast iron, will only cause a change in density of about 3 per cent. through any section, and this would cause a barely perceptible image on the radiograph when using gamma rays.

Vote of Thanks

MR. J. K. JACKSON proposed, and MR. H. BUNTING seconded, saying that defects did get through, and if radiography could improve castings, that was what was required to avoid sending castings with blow-holes to customers.

COMPANY RESULTS

(Figures for previous year in brackets)

Deritend Stamping—Interim dividend of 5% (same).

Hick, Hargreaves—Interim dividend of 2% (same).

Lightalloys—Final dividend of 12½%, making 25% (same).

W. G. Allen & Sons (Tipton)—Interim dividend of 2½% (same).

Aveling-Barford—Interim dividend of 5%, free of tax (same).

Mitchell, Shackleton—Final dividend of 7½%, making 12½% (same).

Rotherham Forge & Rolling Mills—Interim dividend of 5% (same).

Mann Egerton—Net profit, £12,949 (£14,854); dividend of 10% (same).

Ambrose Shardlow & Company—Interim dividend of 2½% on the ordinary shares.

Electric Furnace—Interim dividend of 3½% for the half-year to September 30 (same).

Alliance Aluminium Holdings—Net profit to June 30, £19,665 (£5,356); brought in, £36,519; forward, £56,185.

B. & F. Carter—Trading profit to July 31, £23,915 (£38,446); depreciation, £7,192 (£5,021); tax, £15,774 (£26,444); dividend of 10% (same), £3,000; forward, £8,616 (£11,054).

Shotts Iron—Net profit to September 30, £62,688 (£58,798); depreciation, £35,000 (same); dividend on the ordinary shares of 5% (same); to reserve, £10,000 (nil); forward, £40,123 (£38,915).

Arundel, Coulthard—Net profit for the year ended June 30, £31,352; extra depreciation, £5,000; taxation reserve, £10,000; to investment depreciation reserve, £10,000; dividend of 4%; forward, £26,534.

Matthew Hall & Company—Profit for the year ended December 31, 1942, after providing for depreciation and taxation and charging bank interest, £6,836; debit balance brought in, £19,257; debit forward, £12,421.

John Bedford & Sons—Net profit to September 30 last, £7,065 (£6,509); preference dividend, £1,250 (same); ordinary dividend of 10%, less tax, £3,750 (same); to war contingencies reserve, £3,000 (nil); forward, £5,420 (£6,355).

Burco—Trading profit to September 30, £32,735 (£69,150); depreciation, £5,906 (£5,400); taxation, £3,458 (£39,851); machine tools depreciation, £2,000 (£3,000); rehabilitation reserve, £2,500 (£7,500); general reserve, £5,000 (same); dividend of 15% (same), plus bonus of 2½% (nil); forward, £20,426 (£16,043).

Edward Wood & Company—Trading profit to August 31, £42,474 (£32,001); depreciation, £4,845; net balance, £37,625 (£26,942); preference dividends, less tax, £1,000; dividend of 9% (7½%) on the ordinary shares, less tax, £8,100; to reserve for taxation, £20,000; distributed to employees under profit-sharing scheme, £2,800; forward, £21,188 (£15,463).

Tube Investments—Revenue for the year to October 31, £685,152 (£615,119); interim dividends on the preference and ordinary stock and liaison ordinary shares, £202,288 (same); to reserve, £100,000 (same); to reserve for war contingencies, £100,000 (same); final dividend on the first and second preference stocks, less tax, £14,499; final ordinary dividend of 10%, making 20% for the year (same), less tax, £162,789; dividend on the liaison ordinary shares at the same rate relatively as the ordinary stock, less tax, £25,000; forward, £251,641 (£171,065).

PERSONAL

MR. WALTER S. THOMPSON has been appointed deputy-chairman of Walter Spencer & Company, Limited, Sheffield.

MR. J. S. BUCHANAN has been appointed Assistant Chief Executive at the Ministry of Aircraft Production. He is chairman of the Aircraft Supply Board.

MR. T. WATSON has been appointed to the board of directors of General Refractories, Limited, Sheffield. Mr. Watson joined the company in 1929, and since 1931 has held the position of commercial manager.

MR. LEONARD MORITZ has been appointed a director of British Timken, Limited. He has been a director of Fischer Bearings Company, Limited, for some years, and since British Timken acquired control has been works director and responsible for substantial improvements in production.

SIR JOHN E. THORNYCROFT has become governing director and chairman of John I. Thornycroft & Company, Limited, engineers and shipbuilders. Messrs. T. Donaldson and J. Maughfling and Lieut.-Commander J. W. Thornycroft have been appointed joint managing directors, and Mr. A. H. Musto has been appointed secretary and Mr. N. M. Millard assistant secretary.

MR. WILLIAM BRAZENALL was elected to a seat on the board of directors of Walter Spencer & Company, Limited, Sheffield, at the annual meeting on December 1. Mr. Brazenall is the company's chief metallurgist and steel manager, and has over 27 years' service with the present and original company. He serves on the Ministry of Supply High Speed Steel Advisory Committee and also on the Crucible Steel Management Committee.

Wills

VOGEL, J. L. F., general manager of High Speed Steel Alloys, Limited, Widnes	£3,058
SMITH, C. R., engineer and machinery merchant, carrying on business under the firm name of Smith & Christie, Glasgow	£4,051
THOMAS, COL. L. B., of Madley, Hereford, for some years a director of Richard Thomas & Company, Limited, who died on war service ...	£92,216

CONTRACT OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which tender forms may be obtained.

Bexley, January 15—Sewer ironwork, for the Town Council. The Borough Engineer and Surveyor, Council Offices, Bexleyheath, Kent.

Save Fuel
in your CUPOLAS
by using
STANTON
SAND-LESS
Machine Cast
PIG IRON
THE STANTON IRONWORKS COMPANY
LIMITED NEAR NOTTINGHAM

STEEL INDUSTRY IN AUSTRALIA

DEVELOPING NEW DEPARTMENTS

Mr. H. C. Darling, presiding at the annual meeting of the Broken Hill Proprietary Company, Limited, held in Melbourne on August 27, said that an extremely heavy demand had again been experienced for steel for defence and essential requirements. This had meant the working of the plant to its maximum capacity. As soon as conditions permitted it would be necessary to carry out fairly extensive overhauls, and to provide many additional spares. Labour for general upkeep and repair was in short supply.

The chairman gave the following information with regard to production and sales:

No. 1 blast furnace reached a point where a complete overhaul and re-lining was necessary. This has been completed, and the furnace is again under blast with regular production.

The ferro-alloys plant has been further developed, and is now meeting a wide variety of Australia's requirements in this field. Supplies are difficult to procure from elsewhere. Pre-war stocks of ferro-alloys and raw material have been depleted, but recent arrivals of metallic ores have in the main made the position secure for some time ahead.

Tungsten Carbide Plant

The tungsten carbide plant is working very well. The products in the form of a wide range of tool tips and wire drawing dies are being marketed and used throughout Australia at prices lower than the pre-war price of the equivalent imported article.

Owing to the nature of the wartime demand for special classes of cold-rolled strip it has been found necessary greatly to increase the output.

With the object of further improving blast-furnace practice and increasing the production of basic iron, with a resultant increase in steel output, it has been decided to proceed with the installation of a coal-washing plant at Newcastle.

In order to utilise the flue dust from the blast furnace, a large stock of which has been accumulated over past years, a pilot plant was installed, and from the experiments carried out a satisfactory technique was established for the production of a sinter suitable for blast furnace feed. A decision was made early in the year to instal a full-scale plant. This is now under construction.

The Whyalla blast furnace is proving valuable in that it is to a large extent relieving the New South Wales furnaces of the necessity of producing foundry iron, thus permitting a greater output of basic iron for steel-making purposes. Ferro-manganese requirements have also been produced in this furnace.

Production of Alloy Steels

Australian Iron & Steel, Limited, and Rylands Bros. (Aust.) Pty., Limited, have remained busy. A heavy strain has been imposed on the Commonwealth Steel Company, Limited, consequent upon wartime demands for various steels which had not been previously produced in Australia, and this company is now turning out stainless steel and a diversified range of special alloy and tool steels. To balance output a new acid open-hearth steel furnace is now supplying steel for the tyre and axle plant. Previously this steel was obtained from the Newcastle steelworks.

The Australian Wire Rope Works has had a satisfactory year. The plant has developed into one of the largest of its kind in the British Empire. The other subsidiaries and associated companies have all been busily engaged.

OBITUARY

MR. JOHN GEORGE ROBINSON, late chief mechanical engineer of the Great Central Railway, died at Bournemouth on December 7.

MR. MAX REYNER MAINPRICE, formerly a director and secretary of Brown, Bayley's Steelworks, Limited, Sheffield, has died, aged 62.

MR. MARTIN WINNING, former works manager of Glenfield & Kennedy, Limited, died at Kilmarnock on December 4, in his 86th year.

MR. A. R. HABERSHON has died at Rotherham at the age of 62. He was a director of J. J. Habershon & Sons, Limited, steel rollers.

MR. FREDERICK BAMFORD, of F. Bamford & Company, Limited, marine engineers, Stockport, died on November 29, in his 71st year.

MR. GEORGE LESLIE ARMSTRONG, governing director of Cordingley, Armstrong & Company, Limited, iron and steel merchants, Bradford, has died at Shipley at the age of 82.

MR. WILLIAM G. H. MATTOCK, deputy-chairman and joint managing director of William Sugg & Company, Limited, gas engineers, has died at Herne Bay at the age of 72.

MR. W. H. CONNELL has died at his home in Basingstoke, at the age of 86. He was chairman of the Sheepbridge Stokes Centrifugal Castings Company, Limited, and Sheepbridge Stokes Engine Liners, Limited, and a director of Partridge, Jones & John Paton, Limited, and the Sheepbridge Coal & Iron Company, Limited.

MR. JOHN JOSEPH RALPH died at Wolverhampton on December 4, aged 69. He had been chairman and managing director of A. E. Ralph & Company, Limited, iron and steel merchants, of Birmingham, for the past 25 years. For many years he had been a member of the Birmingham Exchange and Birmingham Chamber of Commerce, and he was well known in the city.

THE DEATH is announced from America of Mr. Donald J. Campbell, the president of Campbell, Wyant & Cannon Foundry Company, of Muskegon, Michigan. Under his direction this concern has become famous for the great progress it has achieved in the production of high-duty cast-iron. Mr. Campbell's noteworthy contributions to this development were recognised by the A.F.A. in 1939 by the presentation of the McFadden gold medal.

Side-Tracked!

EVERY day thousands of wagons are collected in marshalling yards and sent off north, south, east and west. And each wagon stops at somebody's loading bay or siding.

From every quarter voices are calling out for them.

You must help us to get them together again. When they come to you, free them without one minute's needless delay. We did well last year — thanks to you. This year let's do better, for our growing attack calls for more and more transport. In war time all transport lines lead to the battlefront; every vehicle is on its way to our fighting men. Speed their journeys!

QUICKER TURNROUND THAN EVER BEFORE

Issued by the Ministry of War Transport

You know your own problems best. Tackle them in your own way. But tackle them now. Plan, encourage ideas, improvise if needs be. Here's a starting-off agenda:

1. CLEAR LABELS AND DOCUMENTS.
2. LABOUR SAVING DEVICES.
3. WORK IN BLACK-OUT AND AT WEEK-ENDS.
4. OPINIONS OF "MEN WHO DO THE WORK".

8

Raw Material Markets

IRON AND STEEL

With the 1943 programme rapidly approaching completion, interest in the iron and steel industry is now projected across the threshold of the coming year. The impetus of war requirements during the past four years has provided the producing plants and rolling mills with maximum employment. Indeed, the problem has been—and in certain departments still is—to keep pace with an ever-insistent demand. It is by no means certain that these conditions will continue. Mobilisation of the vast resources of the American steel industry for the provision of the specialised needs of modern warfare has now reached such an advanced stage that the pressure upon British iron and steel plants is relaxed, and a shrinkage in the flow of orders has provided an opportunity for the adaptation of plant for the production of new types of material which are more likely to be needed in the final year of the martial quinquennium.

Especially is the slackening of demand noticeable in the pig-iron trade. Some of the blast furnaces are idle, and the units in operation are quite capable of meeting all requirements. Hematite is an exception. There is not enough of this class of iron to go round, because of the scarcity of hematite ores. But the furnaces producing high, medium and low phosphorus irons, as well as those engaged on basic and refined iron, are keeping well abreast of industrial needs, and increased tonnages could be supplied at short notice. No improvement is recorded in the light-castings trade, and of late there has been a shrinkage in the volume of work in hand at some of the engineering foundries.

Ample supplies of coke are available to meet foundry and furnace needs, deliveries coming through regularly from Welsh, Durham and other sources. Stocking accommodation has already been filled up at the consuming end, and present orders are largely for hand-to-mouth supplies at a regular rate. There is little or no delay in the despatch of the requisite requirements of foundries in limestone and ganister, etc. Scrap is generally in sufficient supply.

The recent improvement in the call for finished iron is well maintained, and while conditions vary at different establishments, some of the makers of best bars can only accept orders subject to extended delivery dates.

Aircraft factories are indenting for exceptionally heavy tonnages of high-grade alloy steels. The re-rolling mills are still taking up their maximum quotas of steel billets, blooms, sheet bars, etc. In addition, these establishments are using fairly heavy tonnages of defectives, crops, etc., and these supplies have liberated them from the necessity of using imported material.

The swollen requirements of the British shipyards are alone sufficient to maintain the pressure on the plate and sheet mills; but the interests of marine engineers, boilermakers and power-plant constructors also command attention, and the plate mills are consequently heavily booked over the whole of the first half of 1944. Heavy sections command scant interest, but the demand for lighter sizes and for steel bars is constantly maintained at a high level, and there is no diminution in the flow of orders for black and painted sheets. Considerable quantities of steel are being allocated for colliery use, and appreciable tonnages of roofing bars, arches, rails, etc., are going regularly to the pits. Many of them are now specifying for their quota for delivery in Period I of 1944.

NON-FERROUS METALS

It is announced that the Copper Recovery Corporation, formed early in 1942 in the United States, is being dissolved. This is a measure of the recovery of the situation on the other side of the Atlantic; indeed, it is claimed that the copper supply problem in America has been completely solved. Energetic measures to expand the output and at the same time to economise in consumption have transformed the copper situation both here and in the United States. At the same time there can be little doubt that consumption of the metal has fallen off, particularly in some spheres of munition production. Total absorption of copper is nevertheless very large still, and until the future is more certain than it is at present it is unlikely that supplies will be released for other than war purposes. Lead and zinc, too, are in reasonably good supply, and there is no danger that quantities will fall short of war requirements. Here, again, however, policy dictates the conservation of available supplies, and the Control is unlikely to look with favour on applications for metal for ordinary civilian purposes just yet. Tin, of course, is in a special category, and obviously must be distributed with care so long as the United Nations are denied access to Eastern deposits.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

557,280 GORDON, S. H. Metal containers for fluids under pressure.

557,288 BUDD MANUFACTURING COMPANY, E. G. Method of making stamping dies.

557,358 DE BRUYNE, N. A. Method and apparatus for measuring the amount of coating material applied to a surface.

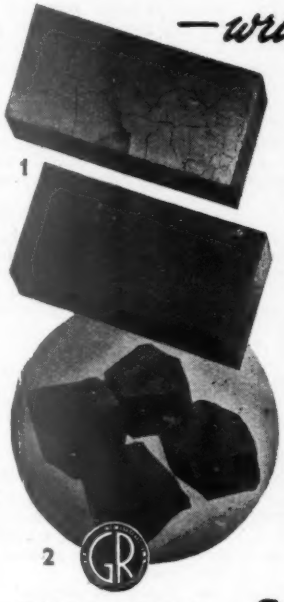
557,386 TAPP, E. T. J. Apparatus for electrolytically treating metal.

557,425 KNAPP & BATES, LIMITED, and KNAPP, E. A. Ore concentration.

557,429 WOODALL-DUCKHAM (1920), LIMITED, and NEWTON, W. T. Construction of retorts for the heat-treatment of materials, furnaces, kilns, and the like.

THE PREMATURE END OF MANY REFRACTORIES

—written in Fireclay Joints



JOINTS are the weakest part of a furnace lining. Ordinary fireclay as a jointing material has certain fundamental disadvantages—it shrinks on drying and again on firing—the bricks do not remain bonded—and fireclay joints are readily attacked by slag. Durax No. 3 Refractory Cement for use with all types of fireclay bricks is a jointing material specially developed to overcome these serious disadvantages. It ensures the thinnest possible joints—sets hard without heat—and does not shrink during drying or firing.

Joints made with Durax No. 3 are as strong and as slag resistant as the fireclay bricks themselves. Its use ensures sound and homogeneous structures from which users can expect long life with a minimum of repairs. Full details on request.

DURAX No. 3 REFRACTORY CEMENT

NO SHRINKAGE. *Illustration (1) shows one firebrick coated with fireclay and the other with Durax No. 3. Both were allowed to dry at atmospheric temperature. The results are easily comparable in the photographic reproductions.*

STRENGTH. *Illustration (2) shows two test pieces allowed to dry at atmospheric temperature, and one fired to 1500° C. Tensile strength results — Unfired: 115 lbs. per sq. in. Fired: 912 lbs. per sq. in.*

FIREBRICKS. BASIC BRICKS
ACID-PROOF MATERIALS
CEMENTS. PLASTICS
INSULATION
SILICA BRICKS
SILLIMANITE. SANDS

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TELEPHONE 31113 (6 LINES) 34.

CURRENT PRICES OF IRON, STEEL AND NON-FERROUS METALS

(Delivered, unless otherwise stated)

Wednesday, December 15, 1943

PIG-IRON

Foundry Iron.—CLEVELAND No. 3: Middlesbrough, 128s.; Birmingham, 130s.; Falkirk, 128s.; Glasgow, 131s.; Manchester, 133s. DERBYSHIRE No. 3: Birmingham, 130s.; Manchester, 133s.; Sheffield, 127s. 6d. NORTHANTS No. 3: Birmingham, 127s. 6d.; Manchester, 131s. 6d. STAFFS No. 3: Birmingham, 130s.; Manchester, 133s. LINCOLNSHIRE No. 3: Sheffield, 127s. 6d.; Birmingham, 130s.

(*No. 1 foundry 3s. above No. 3. No. 4 forge 1s. below No. 3 for foundries, 3s. below for ironworks.*)

Hematite.—No. 1 (S & P 0.03 to 0.05 per cent.): Scotland, N.-E. Coast and West Coast of England, 138s. 6d.; Sheffield, 144s.; Birmingham, 150s.; Wales (Welsh iron), 134s. East Coast No. 3 at Birmingham, 149s.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, 140s. 6d., delivered Birmingham.

Scotch Iron.—No. 3 foundry, 124s. 9d.; No. 1 foundry, 127s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, 174s. South Zone, 176s. 6d.

Refined Malleable.—North Zone, 184s.; South Zone, 186s. 6d.

Cold Blast.—South Staffs, 227s. 6d.

(NOTE.—*Prices of hematite pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton.*)

FERRO-ALLOYS

(*Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.*)

Ferro-silicon (5-ton lots).—25 per cent., £21 5s.; 45/50 per cent., £27 10s.; 75/80 per cent., £43. Briquettes, £30 per ton.

Ferro-vanadium.—35/50 per cent., 15s. 6d. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 9s. 8d. lb.

Tungsten Metal Powder.—98/99 per cent., 9s. 9½d. lb.

Ferro-chrome.—4/6 per cent. C, £59; max. 2 per cent. C, 1s. 6d. lb.; max. 1 per cent. C, 1s. 6½d. lb.; max. 0.5 per cent. C, 1s. 6¾d. lb.

Cobalt.—98/99 per cent., 8s. 9d. lb.

Metallic Chromium.—96/98 per cent., 4s. 5d. lb.

Ferro-manganese.—78/98 per cent., £18 10s.

Metallic Manganese.—94/96 per cent., carb.-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t., 100-ton lots, £12 5s.; tested, up to 0.25 per cent. C, £12 10s.; hard (0.42 to 0.60 per cent. C), £13 17s. 6d.; silico-manganese, £17 5s.; free-cutting, £14 10s. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £15 15s.; case-hardening, £16 12s. 6d.; silico-manganese, £17 5s.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £13 17s. 6d.; basic hard, 0.42 to 0.60 per cent. C, £14 10s.; acid, up to 0.25 per cent. C, £16 5s.

Sheet and Tinplate Bars.—£12 2s. 6d., 6-ton lots.

FINISHED STEEL

[*A rebate of 15s. per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.*]

Plates and Sections.—Plates, ship (N.-E. Coast), £16 3s.; boiler plates (N.-E. Coast), £17 0s. 6d.; chequer plates (N.-E. Coast), £17 13s.; angles, over 4 in. ins., £15 8s.; tees, over 4 in. ins., £16 8s.; joists, 3 in. × 3 in. and up, £15 8s.

Bars, Sheets, etc.—Rounds and squares, 3 in. to 5½ in., £16 18s.; rounds, under 3 in. to ⅜ in. (untested), £17 12s.; flats, over 5 in. wide, £15 13s.; flats, 5 in. wide and under, £17 12s.; rails, heavy, f.o.t., £14 10s. 6d.; hoops, £18 7s.; black sheets, 24 g. (4-ton lots), £22 15s.; galvanised corrugated sheets (4-ton lots), £26 2s. 6d.; galvanised fencing wire, 8g. plain, £26 17s. 6d.

Tinplates.—I.C. cokes, 20 × 14 per box, 29s. 9d., f.o.t. makers' works, 30s. 9d., f.o.b.; C.W., 20×14, 27s. 9d., f.o.t., 28s. 6d., f.o.b.

NON-FERROUS METALS

Copper.—Electrolytic, £62; high-grade fire-refined, £61 10s.; fire-refined of not less than 99.7 per cent., £61; ditto, 99.2 per cent., £60 10s.; black hot-rolled wire rods, £65 15s.

Tin.—99 to under 99.75 per cent., £275; 99.75 to under 99.9 per cent., £276 10s.; min. 99.9 per cent., £278 10s.

Spelter.—G.O.B. (foreign) (duty paid), £25 15s.; ditto (domestic), £26 10s.; "Prime Western," £26 10s.; refined and electrolytic, £27 5s.; not less than 99.99 per cent., £28 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £25; ditto (Empire and domestic), £25; English, £26 10s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, ex works, £37 12s. 6d.; rolled zinc (boiler plates), ex works, £35 12s. 6d.; zinc oxide (Red Seal), d/d buyers' premises, £30 10s.

Other Metals.—Aluminium, ingots, £110; antimony, English, 99 per cent., £120; quicksilver, ex warehouse, £68 10s. to £69 15s.; nickel, £190 to £195.

Brass.—Solid-drawn tubes, 14d. per lb.; brazed tubes, 16d.; rods, drawn, 11¼d.; rods, extruded or rolled, 9d.; sheets to 10 w.g., 10¼d.; wire, 10¼d.; rolled metal, 10¼d.; yellow metal rods, 9d.

Copper Tubes, etc.—Solid-drawn tubes, 15¼d. per lb.; brazed tubes, 15¼d.; wire, 10d.

Phosphor Bronze.—Strip, 13¾d. per lb.; sheets to 10 w.g., 14¾d.; wire, 16d.; rods, 16d.; tubes, 21¼d.; castings, 19d., delivery 3 cwt. free. 10 per cent. phos. cop. £35 above B.S.; 15 per cent. phos. cop. £43 above B.S.; phosphor tin (5 per cent.) £40 above price of English ingots. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 10d. to 1s. 4d. per lb.; rolled to 9 in. wide, 1s. 4d. to 1s. 10d.; to 12 in. wide, 1s. 4¼d. to 1s. 10¼d.; to 15 in. wide, 1s. 4¾d. to 1s. 10¾d.; to 18 in. wide, 1s. 5d. to 1s. 11d.; to 21 in. wide, 1s. 5¼d. to 1s. 11¼d.; to 25 in. wide, 1s. 6d. to 2s. Ingots for spoons and forks, 10d. to 1s. 6¼d. Ingots rolled to spoon size, 1s. 1d. to 1s. 9¼d. Wire round, to 10g., 1s. 7¼d. to 2s. 2¼d., with extras according to gauge. Special 5ths quality turning rods in straight lengths, 1s. 6¼d. upwards.

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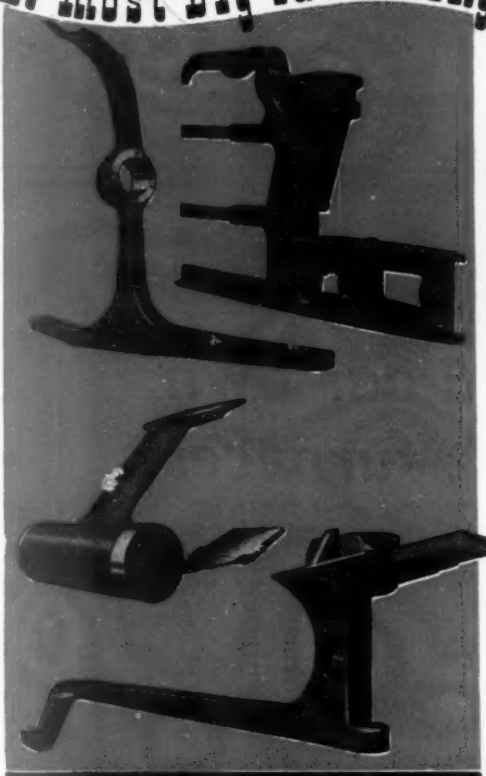

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EST. 1902

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